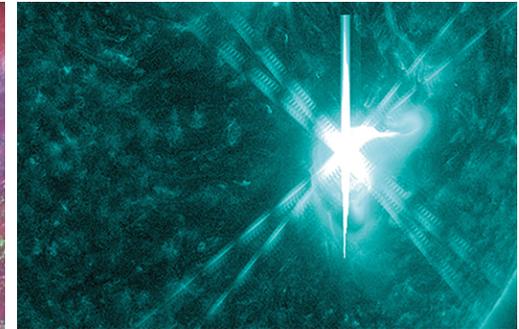
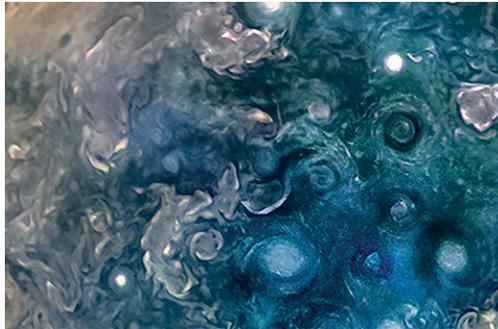


SCIENCE

National Aeronautics and
Space Administration



EVI-5 Pre-Proposal Web Conference

CubeSats – The Basics

Dr. Charles D. Norton

Assistant DAAP, Small Spacecraft Missions
Science Mission Directorate
Charles.D.Norton@nasa.gov

JULY 19, 2018

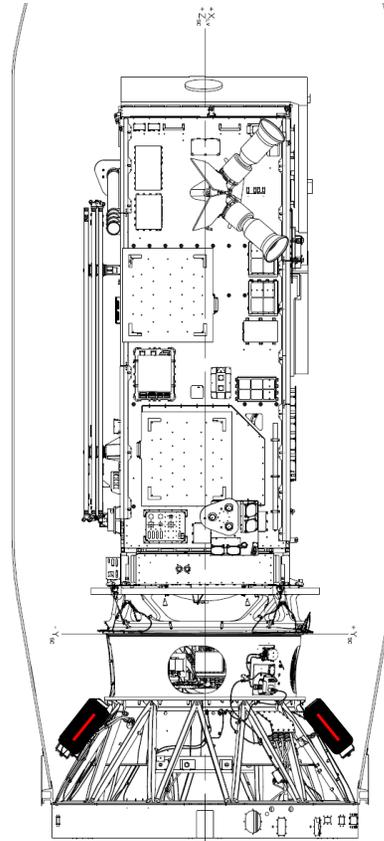
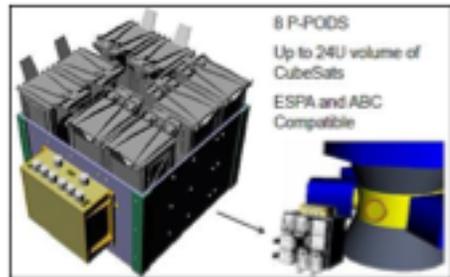


CubeSat Basics

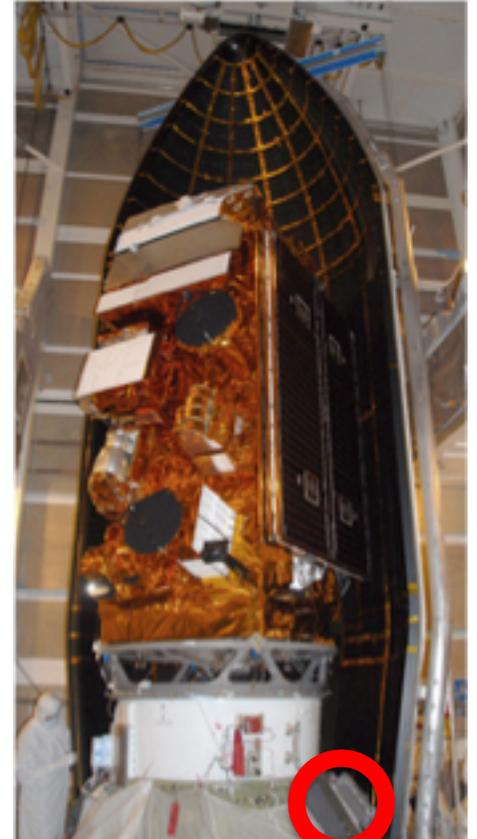
- Satellites in 10x10x10 cm units called “U”s
- Satellites are integrated into a containerized carrier such as the Poly Picosatellite Orbital Dispenser (P-POD) or into larger systems such as the Naval Post-Graduate School CubeSat Launcher (NPSCuL)
- CubeSats can be deployed as a secondary rideshare payload, from a dedicated launch vehicle, or the ISS



3U CubeSat Dispenser Integration



NPP Satellite and P-PODS
(in red) on the Struts



NPP Satellite full fairing
(with Dispensers)



Recent CubeSat Deployments

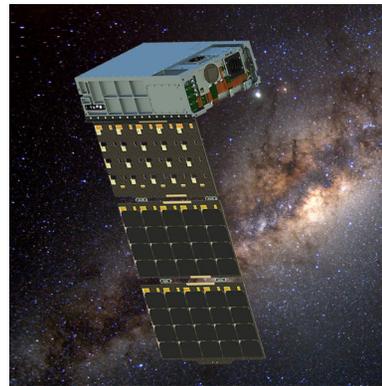
SMD Payloads Launched on May 21, 2018 and Deployed from ISS on July 13, 2018



TEMPEST-D

Radiometer technology for future constellation of SmallSats for temporal observations of cloud and precipitation processes

Venture-Tech



HaloSat

Measuring soft X-Ray emissions from the halo of the Milky Way galaxy to find one-third of the missing matter in the universe

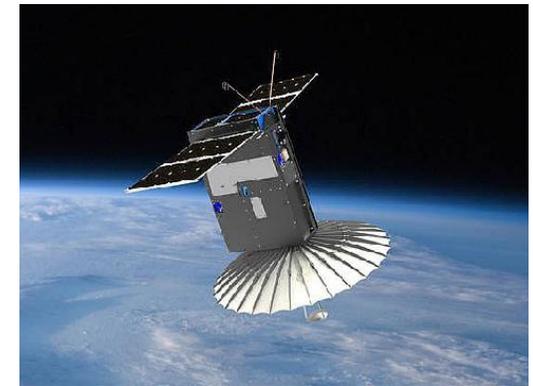
APRA



CubeRRT

Microwave radiometer processing technology to observe, detect, and mitigate radio frequency interference (RFI)

ESTO InVEST



RainCube

Ka-Band active sensing compact radar technology for future SmallSat constellation precipitation measurements

ESTO InVEST

Enabled via the CSLI/ELaNa program with industry partners



Access to Space

Earth Venture Instrument-5
Pre-Proposal
Teleconference/WebEx

- CSLI solicitation is released annually in August
- Multiple launch options supported
 - ISS deployment via CRS missions
 - Rideshare as secondary payload via an EELV
 - Dedicated launch via NASA VCLS program
- Requirements for payload integration may vary based on launch option selected
- Commercial launch brokers also exist

NASA'S CUBESAT LAUNCH INITIATIVE (CSLI)

CSLI:

- PROMOTES innovative public-private technology partnerships
- FACILITATES low-cost technology development
- STRENGTHENS NASA and the Nation's future workforce



LAUNCH PROVIDERS

	 A	 B	 C	 D	 E	 F	TOTAL BY STATUS
MANIFESTED	3	0	2	4	18	21	48
LAUNCHED	15	13	13	1	17	0	59
TOTAL BY PROVIDER	18	13	15	5	35	21	107

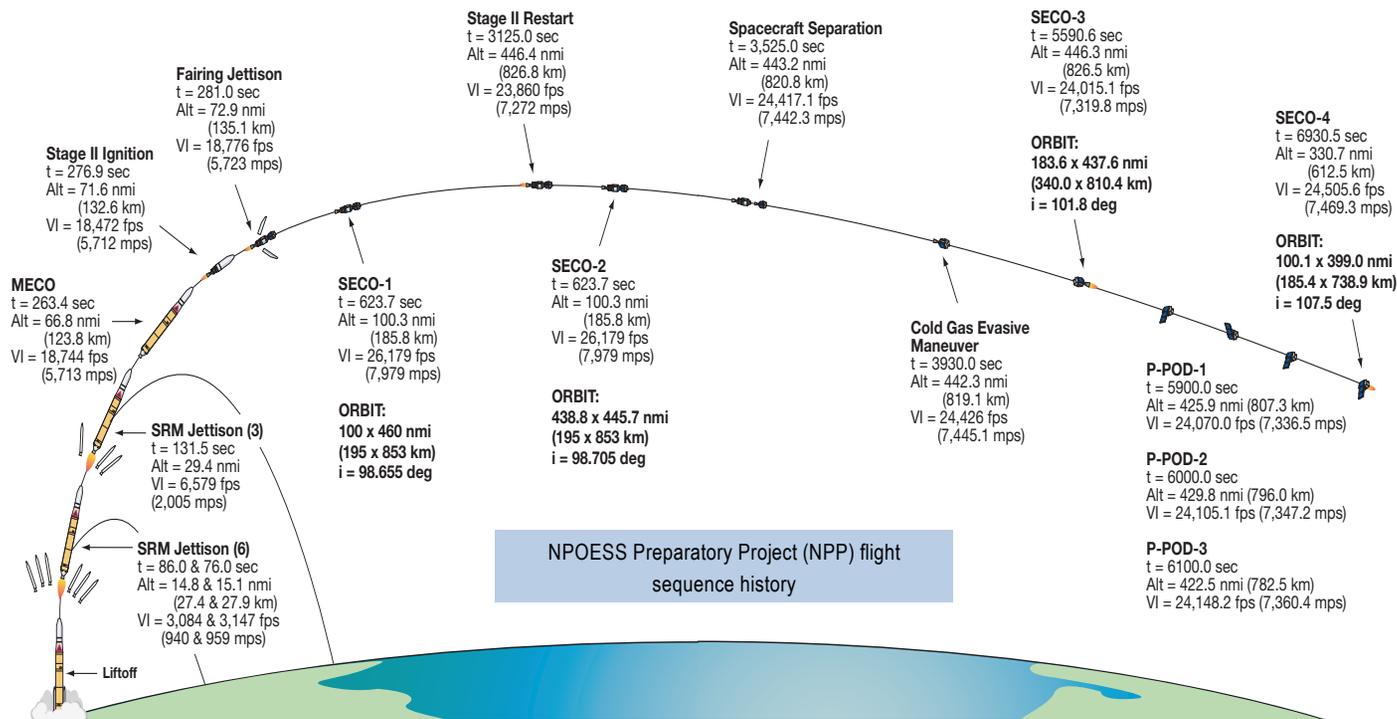
A. NASA B. National Reconnaissance Office C. United States Air Force D. Commercial Expendable Launch Vehicle
E. Commercial from International Space Station F. Venture Class Launch Services (Firefly Space Systems, Rocket Lab USA, Virgin Galactic)

go.nasa.gov/CubeSat_initiative



Sample Flight and Deployment Profile

Earth Venture Instrument-5
Pre-Proposal
Teleconference/WebEx



- Satellites are “powered off” on vehicle ascent (per requirements)
- After primary spacecraft deployment, and vehicle orbital plane change, P-PODS release satellites in sequence
- Satellites “activate” after release then transmit telemetry 30-45 minutes later
- Tracking via GPS, or JSpOC provided TLEs

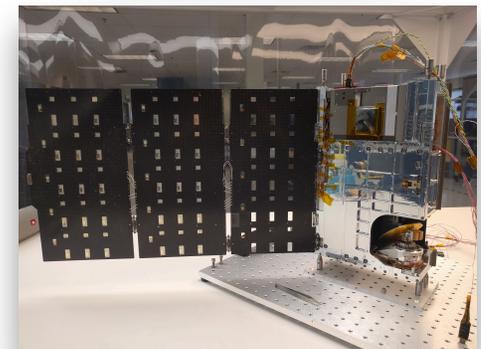
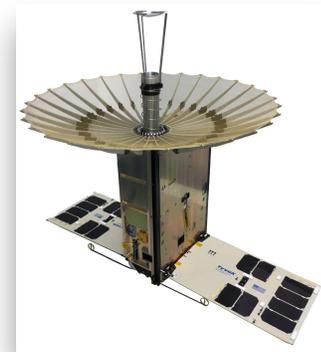


Some Flight Delivery “Got-Cha’s”

Earth Venture Instrument-5
Pre-Proposal
Teleconference/WebEx

- 80 WHr limit for CubeSats battery packs on the ISS
- Failing to carry a backup radio
- Using parts (i.e. Titanium) where the 15J re-entry energy requirement is exceeded
- Selecting components that may be susceptible to Helium
- Insufficient planning for component infant mortality or susceptibility to radiation (i.e. SD-Cards, GPS, ...)

Moral: Seek out lessons learned as much as possible





CubeSat Information Resources

Earth Venture Instrument-5
Pre-Proposal
Teleconference/WebEx

- NASA CubeSat 101 Document
 - **Introduction:** CubeSat dispenser and launch vehicles
 - **Development process overview:** Concept development timelines through operations
 - **Mission models:** NASA/NRO/ORS and APIC mission delivery methods
 - **Requirement sources for launch:** NASA LSP, ICDs, CubeSat Design Specifications, safety, ...
 - **Licensing procedures:** RF and remote sensing licensing
 - **Flight certification documentation:** ODAR, venting, ...
- Small Spacecraft Systems Virtual Institute
 - On-line resources includes technology state of the art report, on-orbit parts database, development tools and more

